# SURVEY SUMMARY REPORT

## PROJECT: FASTTRACK BUS NETWORK EXPANSION

## PREPARED FOR: KENT COUNTY COUNCIL

APRIL 2024

| PROJECT NUMBER: 1551 | | | DOCUMENT REF: 1551-DFL-ELG-XX-RP-EO-13001 | | | |
|---|---|---|---|---|---|---|
| S3 | P03 | Updated based on Arcadis comments. | DS | RC | RC | 03/06/2024 |
| S3 | P02 | Report reviewed: Where relevant guidance and standard versions have been updated to the current date, and any supporting text has been updated. | DS | RC | RC | 22/05/2024 |
| S3 | P01 | For Planning | TP | DS | RC | 12/08/2022 |
| **Suitability** | **Revision** | **Purpose Description** | **Originated** | **Checked** | **Authorised** | **Date** |

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# 1 Introduction

## 1.1 General

1.1.1 This Survey Summary Report has been written by Designs for Lighting Ltd, a lighting design consultancy with experience and knowledge in Lighting Impact Assessments, obtrusive light mitigation, and detailed lighting design.

1.1.2 The objective of the Survey Summary Report is to provide an independent report on the current lighting levels at the Application Site; and the likely future lighting levels for continuous monitoring, for the protection of potentially sensitive ecology that has been identified in the vicinity.

1.1.3 This report is informed by a desktop and on-site assessment of the Application Site, including modelling of light spill and the measurement of baseline lighting levels. The aim of the report is to outline the existing levels and future lighting levels on site.

1.1.4 The Application Site is a former quarry wall and tunnel at the edge of the existing Bluewater Shopping Centre in Dartford, Kent. The Application Site is bounded to the west by roads (Bluewater Parkway) and car parks associated with the shopping centre, to the north by roads, woodland and a substation, to the south by roads and woodland, and to the west by an existing quarry that is being separately developed as a residential scheme.

1.1.5 The Application Site runs through the existing cliff dividing two quarry areas, at the top of which sits the B255, connecting Greenhithe to the north and the A2 to the south. The indicative location of the Application Site is shown in **Figure 1**.

1.1.6 The Proposed Development consists of an illuminated tunnel, with an associated access road and infrastructure, which is intended to be used for bus transit.

1.1.7 Full details regarding the Application Site and Proposed Development description can be found in information accompanying the planning application.

1.1.8 The Proposed Development will require lighting for the purposes of safety and amenity during the hours of darkness. Lighting associated with the Proposed Development has been designed by DFL at a previous phase of the project, with the following lighting calculations informing the conclusions of this report:

- BRT-TG-XX-ZZ-CA-LI-1301-S3-P04; and
- BRT-TG-XX-ZZ-CA-LI-1302-S3-P02.

1.1.9 Lighting designs for the Proposed Development are presented in **Appendix 1**.

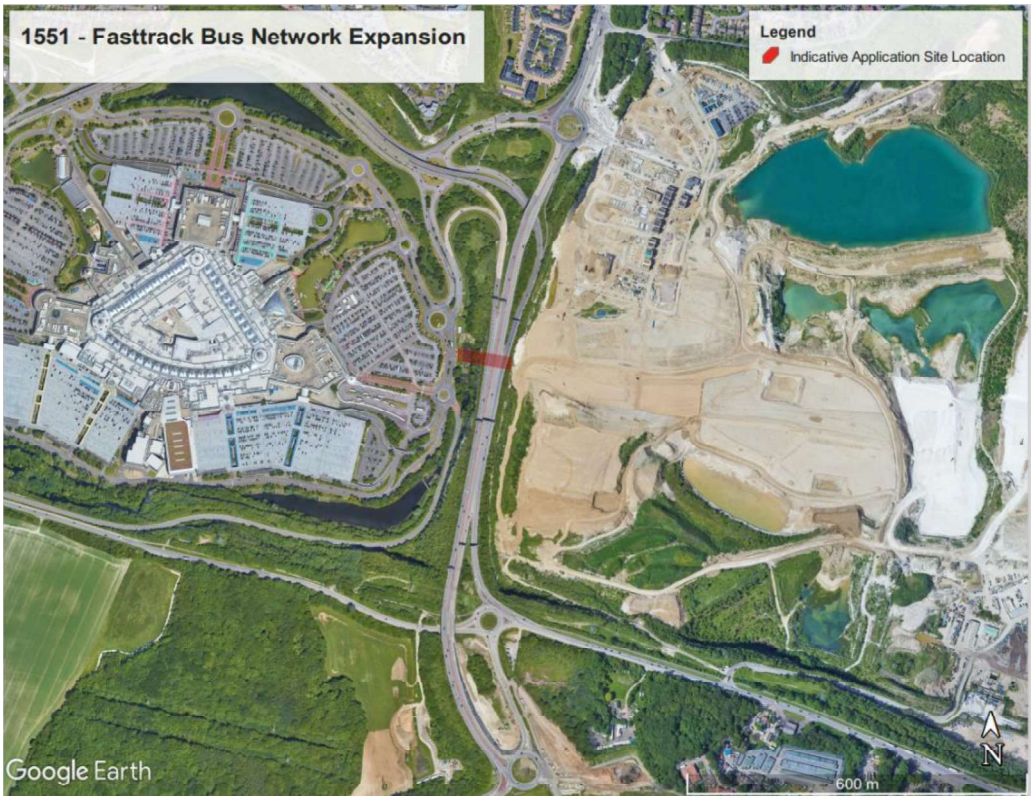



**Figure 1 – Indicative Application Site Location**

# 2 Legislative and Policy Framework

## 2.1 National Policy and Legislation

**Environmental Protection Act 1990 / Clean Neighbourhoods and Environment Act 2005**

2.1.1 Since 2005, artificial light has been incorporated as a potential statutory nuisance. An amendment to section 79 of the Environmental Protection Act 1990, contained within the Clean Neighbourhoods and Environment Act 2005 states:

*"Artificial light emitted from premises so as to be prejudicial to health and nuisance constitutes a 'Statutory Nuisance' and it shall be the duty of every local authority to cause its area to be inspected from time to time to detect any statutory nuisances which ought to be dealt with under section 80 and, where a complaint of a statutory nuisance is made to it by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint".*

**National Planning Policy Framework 2023**

2.1.2 The National Planning Policy Framework (NPPF) sets out the government's planning policies for England and how they are expected to be applied and provides a framework for local plans. With regard to light pollution, the NPPF was updated in December 2023 and states that the following elements are to be considered:

*"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:*

*a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*

*b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*

*c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."*

**Planning Practice Guidance**

*2.1.3* Guidance for assessing the effects of proposed artificial lighting is outlined in the planning practice guidance (PPG). The guidance states:

- *"Does an existing lighting installation make the proposed location for a development unsuitable, or suitable only with appropriate mitigation? For example, this might be because:*
  - *the artificial light has a significant effect on the locality; and/or*
  - *users of the Proposed Development (e.g., a hospital) may be particularly sensitive to light intrusion from the existing light source.*

    *Where necessary, development proposed in the vicinity of existing activities may need to put suitable mitigation measures in place to avoid those activities having a significant adverse effect on residents or users of the proposed scheme, reflecting the agent of change principle. Additional guidance on applying this principle is set out in the planning practice guidance on noise.*
  - *Will a new development, or a proposed change to an existing site, be likely to materially alter light levels in the environment around the site and/or have the potential to adversely affect the use or enjoyment of nearby buildings or open spaces?*
  - *Will the impact of new lighting conflict with the needs of specialist facilities requiring low levels of surrounding light (such as*

*observatories, airports and general aviation facilities)? Impacts on other activities that rely on low levels of light such as astronomy may also be a consideration but will need to be considered in terms of both their severity and alongside the wider benefits of the development.*

- *Is the development in or near a protected area of dark sky or an intrinsically dark landscape where new lighting would be conspicuously out of keeping with local nocturnal light levels, making it desirable to minimise or avoid new lighting?*
- *Would new lighting have any safety impacts, for example in creating a hazard for road users?*
- *Is a proposal likely to have a significant impact on a protected site or species? This could be a particular concern where forms of artificial light with a potentially high impact on wildlife and ecosystems (e.g. white or ultraviolet light) are being proposed close to protected sites, sensitive wildlife receptors or areas, including where the light is likely to shine on water where bats feed.*
- *Does the Proposed Development include smooth, reflective building materials, including large horizontal expanses of glass, particularly near water bodies? (As it may change natural light, creating polarised light pollution that can affect wildlife behaviour.)"*

## 2.2 Local Policy

**Dartford Borough Council – Local Plan 2024- 2037 (Adopted April 2024)**

2.2.1 The local authority to the Proposed Development is Dartford Borough Council, whose Local Plan 2024-2037 (Adopted April 2024) forms the starting point for most decisions on planning applications.

2.2.2 The most relevant policies to the application of lighting within the Local Plan 2024-2037 are:

*"Policy M2: Environmental and Amenity Protection*

*1. Development must demonstrate that it is designed and located to not result in unacceptable material impacts, individually or cumulatively, on neighbouring uses, the Borough's environment or public health. Particular consideration must be given to the design of proposals in order to mitigate or remove impacts in areas and subjects of potential sensitivity in the built and natural environment (including as highlighted on the Policies Map), and other potential amenity/ safety factors including:*

- *At developments generating adverse material impacts on air quality without adequate mitigation,*
- *At all forms of development introducing receptors especially sensitive to adverse air quality (in particular within or immediately adjacent to Air Quality Management Areas);*
- *And, for any development, with respect to:*
  - *a. water quality, including groundwater source protection zones;*
  - *b. intensity of use, including hours of operation;*
  - *c. anti-social behaviour and littering;*
  - *d. traffic, access, and parking;*
  - *e. noise disturbance or vibration;*
  - *f. odour;*

*g. light pollution;*

*h. overshadowing, overlooking and privacy;*

*i. electrical and telecommunication interference;*

*j. HSE land use consultation zones;*

*k. land instability; and*

*l. ground contamination and gassing.*

*2. Development must not materially impede the continuation of lawfully existing uses. Where impacts cannot be adequately mitigated, planning applications are likely to be refused.*

*…."*

*"Policy M12: Green Belt*

*1. Dartford Borough's Green Belt is shown on the Policies Map, and its essential characteristics are its openness and permanence. Inappropriate development in the Green Belt will be resisted in accordance with national planning policy.*

*2. Inappropriate development is by definition harmful to the Green Belt and will only be approved in very special circumstances. Very special circumstances will not exist unless potential harm to the Green Belt by reason of inappropriateness, and any other harm, is clearly outweighed by other considerations.*

*3. In assessing other harm, the following criteria will be included in the local planning authority's consideration:*

*a. The extent of intensification of the use of the site;*

*b. The impact of an increase in activity and disturbance resulting from the development, both on and off the site, including traffic movement and parking, light pollution and noise;*

*c. The impact on biodiversity and wildlife;*

*d. The impact on visual amenity or character taking into account the extent of screening required; and*

*e. Impacts arising from infrastructure required by the development.*

*4. In assessing harm, development proposals will need to accord with, the objectives, purposes and essential characteristics of the Green Belt, particularly in terms of preserving permanent openness. Developments will also be assessed against the following criteria where applicable."*

**Kent County Council – KCC Highways Asset Management Technical Advice Note V7 23/01**

2.2.3 The Application Site is located in the county of Kent, who act as the adopting authority for highways proposals within the County. Therefore, adoptable highways that form part of the Proposed Development shall be lit in accordance with Kent County Council's (KCC) adoptable highway lighting specification.

2.2.4 This specification is set out in the KCC Highways Asset Management Technical Advice Note 23/01, which sets out approaches to lighting to be taken, supported by the associated Street lighting list of Approved Apparatus.

# 3 Standards and Guidance

## 3.1 British Standards

3.1.1 The applicable British Standards for lighting that relate to the Proposed Development are:

- **BS5489-1: 2021 –** *Lighting of Roads and Public Amenity Areas - Code of practice.* **–** This guidance is applicable to the lighting of roads that facilitate movement of vehicular traffic.
- **BS5489-2: 2016 –** *Code of practice for the design of road lighting* **–** *Part 2: Lighting of tunnels* **–** This guidance is applicable to the lighting of the proposed tunnel that forms the bulk of the Proposed Development.
- **BS EN 13201 Part 2: 2015** - *Road lighting. Performance requirements* is applicable to the selection of lighting classes within the Proposed Development.

## 3.2 Guidance Notes for the Reduction of Obtrusive Light (GN01:2021)

3.2.1 This summary report and the baseline survey is informed by the most relevant sections of GN01/21 that has recently been published to reduce the potential for obtrusive light from a wide range of exterior lighting applications. Notably, the updated guidance has been specifically aimed at systems of flood lighting, as such some sections relating to luminaire source intensity are not applicable to this Lighting Impact Assessment.

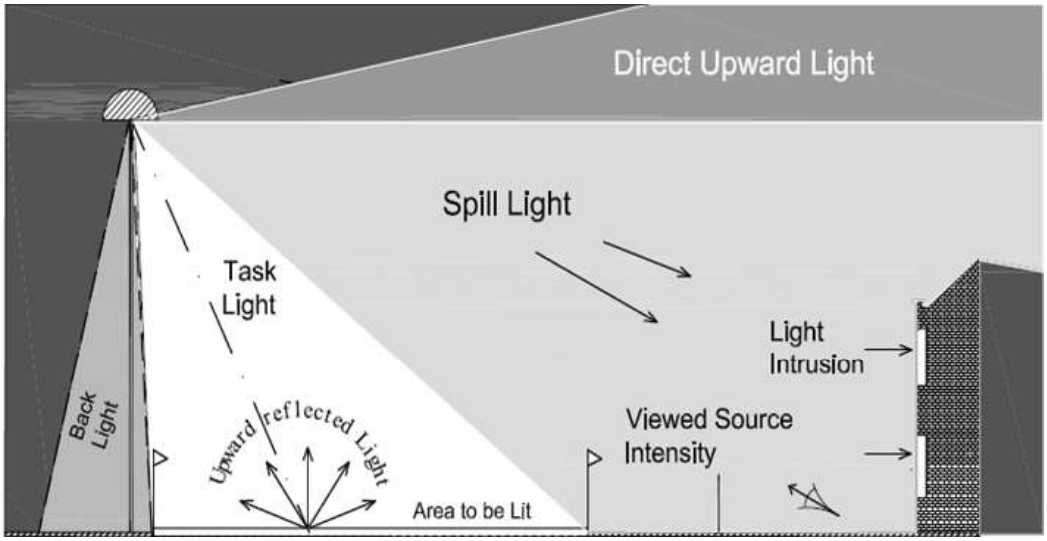



Figure 2 Obtrusive light diagram

## 3.3 GN08/23 Bats and Artificial Lighting in the UK – Bat Conservation Trust and Institution of Lighting Professionals

3.3.1 Guidance for artificial lighting and bats was updated in 2023, the guidance states the following:

*"It is acknowledged that, especially for vertical calculation planes, very low levels of light (<0.5 lux) may occur even at considerable distances from the source if there is little intervening attenuation. It is therefore very difficult to demonstrate 'complete darkness' or a 'complete absence of illumination' on vertical planes where some form of lighting is proposed on site despite efforts to reduce them as far as possible and where horizontal plane illuminance levels are zero. Consequently, where 'complete darkness' on a feature or buffer is required, it may be appropriate to consider this to be where illuminance is below 0.2 lux on the horizontal plane and below 0.4 lux on the vertical plane. These figures are still lower than what may be expected on a moonlit night and are in line with research findings for the illuminance found at hedgerows used by lesser horseshoe bats, a species well known for its light averse behaviour (Stone, 2012)."*

# 4 Methodology

## 4.1 Methodology

4.1.1 This survey summary report seeks to establish the baseline lighting levels at points to the west and east of the proposed tunnel entrances, as agreed with Natural England.

4.1.2 Due to access constraints caused by site conditions, different methodologies were required to determine the baseline lighting levels at each side of the tunnel.

## 4.2 Western Face

4.2.1 The western face of the proposed tunnel faces into the existing Bluewater Shopping Centre, across a planted boundary adjacent to the existing Bluewater Parkway roadway.

4.2.2 The approach for the western face was agreed and undertaken in accordance with the approach put forward in the survey method statement, 1551-DFL-ELG-XX-SU-EO-13001. The survey method statement is included for reference in **Appendix 2**.

4.2.3 This approach involved undertaking readings of baseline illuminance levels adjacent to the existing Bluewater Parkway roadway, adjacent to the existing lagoons and on a track running perpendicular to the cliff face – such that the likely levels of horizontal and vertical illuminance at the cliff face could be interpolated from data that could be safely gathered.

4.2.4 Readings could not be taken directly at the base of the cliff face due to the risks associated with falling rock and debris. Illuminance measurements have therefore been taken as close to the cliff face as was deemed safe.

## 4.3 Eastern Face

4.3.1 The eastern face of the proposed tunnel faces into the construction site for ongoing residential development to the east of the B255. This area could not be safely accessed due to the risks associated with falling rocks and debris, ground conditions and active excavations.

4.3.2 To determine the baseline lighting level at the eastern face of the proposed tunnel baseline lighting data was taken from lighting designs prepared for adjacent roads, specifically the B255, the B255 – A296 roundabout to the south of the Application Site and the B255 – Bluewater Parkway roundabout to the north of the Application Site.

4.3.3 Lighting design for these roads was undertaken by DFL-UK as part of the Kent County Council LED Replacement Programme. As a result, DFL have access to all lighting details for the roads adjacent to the Application Site. The lighting design results are summarised in calculation 10506137M-Dartford-Calc-St Clements Way-1-R1, which is included in **Appendix 3**.

4.3.4 Other data, such as publicly available sky glow mapping to determine the existing lighting conditions in the vicinity of the Application Site, has been used to inform the characterisation of the baseline lighting levels in the vicinity of the Application Site.

4.3.5 There are unlikely to be separate private sources of lighting currently illuminating the eastern cliff face due to the limited occupied development currently present on site, however, residential development of the site is ongoing and may cause increases in light pollution in the future that are unrelated to the Proposed Development.

## 4.4 Effects from light on bat roosts and insects

4.4.1 Light falling on a roost access point will at least delay some species of bats from emerging and this shortens the amount of time available to them for foraging. As the main peak of nocturnal insect abundance occurs at and soon after dusk, a delay in emergence means this vital time for feeding is missed.

4.4.2 In addition to the above, artificial lighting can also affect the feeding behaviour of bats. There are two aspects to this - one is the attraction that light from certain types of lamps has to a range of insects; the other is the presence of lit conditions which causes bats to exhibit their light adverse behaviour, and thus reduces the size of the area they can feed in.

## 4.5 Classification of Environmental Zones

4.5.1 The ILP Guidance Notes Guide quantify the levels of Obtrusive light regarded as acceptable for varying Environmental Zones Environmental Zones E0 to E4.

4.5.2 The site is described as exhibiting 'Medium district brightness' (as set out in **Section 5.2**), and is therefore categorised as an **E3** Environmental Zone in accordance with the ILP Guidance Notes, due to its partially developed lit environment.

| Zone | Surrounding | Lighting Environment | Examples |
|---|---|---|---|
| E0 | Protected | Dark (SQM 20.5 +) | Astronomical Observable dark skies, UNESCO starlight reserves, IDA Dark Sky Parks |
| E1 | Natural | Intrinsically dark (SQM 20 to 20.5) | Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty etc |
| E2 | Rural | Low district brightness (SQM ~ 15 to 20) | Sparsely inhabited rural areas, Village or relatively dark outer suburban locations |
| **E3** | **Suburban** | **Medium district brightness** | **Well inhabited rural and urban settlements, Small town centres or suburban locations** |
| E4 | Urban | High district brightness | Town / City centres with high levels of night-time activity |

**Table 1 Environmental Zones**

*Notes:*
1. Where an area to be lit lies on the boundary of two zones the obtrusive light limitation values used should be those applicable to the most rigorous zone.
2. Rural zones under protected designations should use a higher standard of policy.
3. Zone E0 must always be surrounded by an E1 Zone.
4. Zoning should be agreed with the local planning authority and due to local requirements a more stringent zone classification may be applied to protect special/specific areas.
5. SQM (Sky Quality Measurements) referenced by the International Dark-Sky Association (IDA), the criteria for E0 being revised in mid-2019 but not retrospective.
6. Astronomical observable dark skies will offer clearer views of the Milky Way and of other objects such as the Andromeda galaxy and the Orion Nebula.
7. Although values of SQM 20 to 20.5 may not offer clear views of astronomical dark sky objects such as the Milky Way, these skies will have their own relative intrinsic value in the UK.

## 4.6 Obtrusive Light Limitations

4.6.1 In the absence of suitable statutory guidance, the ILP "Guidance Notes for the Reduction of Obtrusive Light" GN01:2021 is typically used, in order to provide suitable assessment criteria against which to assess the likely effects of artificial lighting.

4.6.2 The relevant criteria of upward light, light intrusion and direct source intensity are discussed below and **Table 2** sets limits for each criterion.

| Environmental Zones | Sky Glow ULR (Max %) | Light Trespass (into Windows) $E_v$ (lux) | | Building Luminance Average, Pre-curfew |
|---|---|---|---|---|
| | | Pre- Curfew | Post-Curfew | Average L (cd/m$^2$) |
| E0 | 0 | 0 | 0 | < 0.1 |
| E1 | 0 | 2 | < 0.1 (1*) | < 0.1 |
| E2 | 2.5 | 5 | 1 | 5 |
| **E3** | **5** | **10** | **2** | **10** |
| E4 | 15 | 25 | 5 | 25 |

**Table 2 Obtrusive light criteria relating to each Environmental Zones**

*Note:* * If the installation is for public (road) lighting then this may be up to 1 lx.

# 5 Baseline Conditions - West

## 5.1 Methodology

5.1.1 The approach to gather levels of baseline illuminance at the Application Site are set out in the survey method statement, 1551-DFL-ELG-XX-SU-EO-13001. The survey method statement is included for reference in **Appendix 2**.

5.1.2 Measurements were taken in 3 tracks: perpendicular to the cliff face (track 1), parallel to the cliff face adjacent to existing lagoons (track 2) and adjacent to the existing Bluewater Parkway roadway (track 3).

5.1.3 A diagram showing track 1 & 2 is presented in **Figure 3**:

Figure 3 Baseline Survey Measurement Points

5.1.4 These points were then used to interpolate the levels at the cliff face. This was achieved by noting the reduction factor affecting points along track 1; and applying this factor to results gathered on tracks 2 & 3.

5.1.5 A laser distance measure was used onsite to determine the distance of a given point from the cliff face. Points were taken along tracks at 2.5 metre intervals.

## 5.2 Baseline Survey

5.2.1 A baseline survey of the Application Site was undertaken during the evening of the 28th of July 2022 by two lighting professionals experienced and qualified to undertake such surveys.

5.2.2 The survey was undertaken following the onset of astronomical dusk (22:32 hours). Weather conditions were clear. The moon phase was a New Moon, with the moon 0% visible (as taken from https://moonphases.co.uk). Therefore, Moonlight did not affect the baseline survey readings.

5.2.3 Illuminance measurements were taken in the horizontal plane and in vertical planes facing north, east, south and west, providing 5 illuminance readings per measurement location.

5.2.4 Measurements were taken using a Hagner T-10 Illuminance Meter (serial number 55611050) which has a valid calibration certificate (certificate No: LB201401) and is widely regarded as the standard instrument for providing a consistent level of accuracy at the low illuminance levels associated with site measurements in locations with typically low ambient luminance.

5.2.5 Results gathered during the baseline survey varied between 0.10 lux and 15.94 lux depending upon the proximity to the cliff face and the direction of the measurement.

## 5.3 Results

5.3.1 The results gathered during the baseline survey are presented in **Appendix 4**.

5.3.2 The results taken at measurement positions 1 – 18 were used to interpolate the anticipated light levels at the cliff face. The results of this interpolation are shown in **Tables 3 – 7**.

| Measurement Position | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | Cliff Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.71 | 0.95 | 0.60 | 0.35 | 0.32 | 0.13 | 0.10 | 0.11 | 0.12 | 0.10 | 0.08 | 0.07 |
| 10 | 1.22 | 1.63 | 1.03 | 0.60 | 0.55 | 0.22 | 0.17 | 0.19 | 0.16 | 0.13 | 0.10 | 0.09 |
| 9 | 1.53 | 2.05 | 1.29 | 0.75 | 0.69 | 0.28 | 0.22 | 0.24 | 0.19 | 0.16 | 0.13 | 0.11 |
| 8 | 0.25 | 0.33 | 0.21 | 0.12 | 0.11 | 0.05 | 0.04 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 |
| 7 | 1.61 | 2.15 | 1.36 | 0.79 | 0.73 | 0.29 | 0.23 | 0.25 | 0.20 | 0.17 | 0.14 | 0.11 |
| 6 | 0.42 | 0.56 | 0.35 | 0.21 | 0.19 | 0.08 | 0.06 | 0.07 | 0.05 | 0.04 | 0.04 | 0.03 |
| 5 | 0.49 | 0.66 | 0.41 | 0.24 | 0.22 | 0.09 | 0.07 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 |
| 4 | 0.51 | 0.68 | 0.43 | 0.25 | 0.23 | 0.09 | 0.07 | 0.08 | 0.06 | 0.05 | 0.04 | 0.04 |
| 3 | 0.47 | 0.63 | 0.40 | 0.23 | 0.21 | 0.09 | 0.07 | 0.07 | 0.06 | 0.05 | 0.04 | 0.03 |
| 2 | 0.42 | 0.56 | 0.35 | 0.21 | 0.19 | 0.08 | 0.06 | 0.07 | 0.05 | 0.04 | 0.04 | 0.03 |
| 1 | 0.34 | 0.45 | 0.29 | 0.17 | 0.15 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 | 0.02 |

Table 3 Measured and Interpolated Results – Horizontal (lux)

| Measurement Position | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | Cliff Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.90 | 0.44 | 0.21 | 0.23 | 0.29 | 0.26 | 0.06 | 0.07 | 0.08 | 0.07 | 0.05 | 0.04 |
| 10 | 0.80 | 0.39 | 0.19 | 0.20 | 0.26 | 0.23 | 0.05 | 0.06 | 0.05 | 0.04 | 0.03 | 0.03 |
| 9 | 1.02 | 0.50 | 0.24 | 0.26 | 0.33 | 0.29 | 0.07 | 0.08 | 0.06 | 0.05 | 0.04 | 0.03 |
| 8 | 1.09 | 0.53 | 0.25 | 0.28 | 0.35 | 0.31 | 0.07 | 0.08 | 0.07 | 0.05 | 0.04 | 0.04 |
| 7 | 1.18 | 0.58 | 0.28 | 0.30 | 0.38 | 0.34 | 0.08 | 0.09 | 0.07 | 0.06 | 0.05 | 0.04 |
| 6 | 1.19 | 0.58 | 0.28 | 0.30 | 0.38 | 0.34 | 0.08 | 0.09 | 0.07 | 0.06 | 0.05 | 0.04 |
| 5 | 1.35 | 0.66 | 0.32 | 0.35 | 0.44 | 0.39 | 0.09 | 0.11 | 0.08 | 0.07 | 0.05 | 0.04 |
| 4 | 1.54 | 0.75 | 0.36 | 0.39 | 0.50 | 0.44 | 0.10 | 0.12 | 0.10 | 0.08 | 0.06 | 0.05 |
| 3 | 0.51 | 0.25 | 0.12 | 0.13 | 0.16 | 0.15 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 |
| 2 | 1.95 | 0.95 | 0.46 | 0.50 | 0.63 | 0.56 | 0.13 | 0.15 | 0.12 | 0.10 | 0.08 | 0.06 |
| 1 | 1.64 | 0.80 | 0.38 | 0.42 | 0.53 | 0.47 | 0.11 | 0.13 | 0.10 | 0.08 | 0.07 | 0.05 |

Table 4 Measured and Interpolated Results – Vertical (lux) North

| Measurement Position | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | Cliff Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.50 | 0.49 | 0.51 | 0.48 | 0.54 | 0.43 | 0.02 | 0.03 | 0.05 | 0.04 | 0.04 | 0.03 |
| 10 | 0.49 | 0.48 | 0.50 | 0.47 | 0.53 | 0.42 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 |
| 9 | 0.51 | 0.50 | 0.52 | 0.49 | 0.55 | 0.44 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 |
| 8 | 0.50 | 0.49 | 0.51 | 0.48 | 0.54 | 0.43 | 0.02 | 0.03 | 0.03 | 0.03 | 0.02 | 0.02 |
| 7 | 0.54 | 0.53 | 0.55 | 0.52 | 0.58 | 0.46 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 |
| 6 | 0.57 | 0.56 | 0.58 | 0.55 | 0.62 | 0.49 | 0.02 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 |
| 5 | 0.64 | 0.63 | 0.65 | 0.61 | 0.69 | 0.55 | 0.03 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 |
| 4 | 0.74 | 0.73 | 0.75 | 0.71 | 0.80 | 0.64 | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 |
| 3 | 0.72 | 0.71 | 0.73 | 0.69 | 0.78 | 0.62 | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 |
| 2 | 0.72 | 0.71 | 0.73 | 0.69 | 0.78 | 0.62 | 0.03 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 |
| 1 | 0.68 | 0.67 | 0.69 | 0.65 | 0.73 | 0.58 | 0.03 | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 |

Table 5 Measured and Interpolated Results – Vertical (lux) East

| Measurement Position | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | Cliff Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.57 | 1.21 | 0.89 | 0.66 | 0.42 | 0.41 | 0.45 | 0.43 | 0.41 | 0.35 | 0.29 | 0.25 |
| 10 | 1.44 | 1.11 | 0.82 | 0.61 | 0.39 | 0.38 | 0.41 | 0.39 | 0.33 | 0.28 | 0.24 | 0.20 |
| 9 | 1.48 | 1.14 | 0.84 | 0.62 | 0.40 | 0.39 | 0.42 | 0.41 | 0.34 | 0.29 | 0.24 | 0.21 |
| 8 | 1.33 | 1.03 | 0.75 | 0.56 | 0.36 | 0.35 | 0.38 | 0.36 | 0.31 | 0.26 | 0.22 | 0.19 |
| 7 | 2.01 | 1.55 | 1.14 | 0.84 | 0.54 | 0.52 | 0.58 | 0.55 | 0.47 | 0.39 | 0.33 | 0.28 |
| 6 | 1.86 | 1.43 | 1.05 | 0.78 | 0.50 | 0.49 | 0.53 | 0.51 | 0.43 | 0.36 | 0.31 | 0.26 |
| 5 | 1.86 | 1.43 | 1.05 | 0.78 | 0.50 | 0.49 | 0.53 | 0.51 | 0.43 | 0.36 | 0.31 | 0.26 |
| 4 | 2.96 | 2.28 | 1.68 | 1.24 | 0.79 | 0.77 | 0.85 | 0.81 | 0.68 | 0.58 | 0.49 | 0.41 |
| 3 | 2.21 | 1.70 | 1.25 | 0.93 | 0.59 | 0.58 | 0.63 | 0.61 | 0.51 | 0.43 | 0.36 | 0.31 |
| 2 | 2.13 | 1.64 | 1.21 | 0.90 | 0.57 | 0.56 | 0.61 | 0.58 | 0.49 | 0.42 | 0.35 | 0.30 |
| 1 | 1.84 | 1.42 | 1.04 | 0.77 | 0.49 | 0.48 | 0.53 | 0.50 | 0.43 | 0.36 | 0.30 | 0.26 |

**Table 6 Measured and Interpolated Results – Vertical (lux) South**

| Measurement Position | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | | | | Cliff Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.45 | 1.93 | 1.41 | 1.07 | 0.63 | 0.63 | 0.62 | 0.55 | 0.49 | 0.40 | 0.33 | 0.27 |
| 10 | 3.13 | 2.47 | 1.80 | 1.37 | 0.80 | 0.80 | 0.79 | 0.70 | 0.58 | 0.47 | 0.39 | 0.32 |
| 9 | 3.73 | 2.94 | 2.15 | 1.63 | 0.96 | 0.96 | 0.94 | 0.84 | 0.69 | 0.56 | 0.46 | 0.38 |
| 8 | 3.59 | 2.83 | 2.07 | 1.57 | 0.92 | 0.92 | 0.91 | 0.81 | 0.66 | 0.54 | 0.44 | 0.36 |
| 7 | 4.28 | 3.37 | 2.46 | 1.87 | 1.10 | 1.10 | 1.08 | 0.96 | 0.79 | 0.65 | 0.53 | 0.43 |
| 6 | 4.58 | 3.61 | 2.64 | 2.00 | 1.18 | 1.18 | 1.16 | 1.03 | 0.84 | 0.69 | 0.57 | 0.46 |
| 5 | 2.71 | 2.13 | 1.56 | 1.18 | 0.70 | 0.70 | 0.69 | 0.61 | 0.50 | 0.41 | 0.33 | 0.27 |
| 4 | 4.33 | 3.41 | 2.49 | 1.89 | 1.11 | 1.11 | 1.10 | 0.97 | 0.80 | 0.65 | 0.54 | 0.44 |
| 3 | 2.36 | 1.86 | 1.36 | 1.03 | 0.61 | 0.61 | 0.60 | 0.53 | 0.43 | 0.36 | 0.29 | 0.24 |
| 2 | 4.42 | 3.48 | 2.54 | 1.93 | 1.14 | 1.14 | 1.12 | 0.99 | 0.81 | 0.67 | 0.55 | 0.45 |
| 1 | 4.09 | 3.22 | 2.35 | 1.79 | 1.05 | 1.05 | 1.04 | 0.92 | 0.75 | 0.62 | 0.51 | 0.41 |

**Table 7 Measured and Interpolated Results – Vertical (lux) West**

5.3.3 The results gathered during the baseline survey indicated that lighting levels gradually reduce with proximity to the cliff face, as is to be expected given the increasing distance from the nearest light source.

5.3.4 The Application Site is more brightly lit to the west, with lighting sources associated with the Bluewater Shopping Centre and associated roads increasing the baseline illuminance.

5.3.5 Horizontal readings in proximity to the cliff face included light spill from the adjacent B255, which was visible for the duration of the survey and from all measurement positions.

5.3.6 Lighting provided to the B255 is likely to cause a small increase in light spill at the cliff base.

5.3.7 It was also noted during the baseline survey that the cliff face radiated a notable level of light, due to the chalky white surface with a high reflectance value.

5.3.8 The results gathered during the baseline survey indicate that lighting levels at the cliff face exceed the 0.40 lux Vertical Illuminance level identified within ILP GN08:2023 for darkness on a feature.

# 6 Baseline Conditions - East

## 6.1 Methodology

6.1.1 To determine the baseline lighting levels at the eastern cliff face, a combination of data sources were used. This area could not be safely accessed for a baseline survey due to the risks associated with falling rocks and debris, ground conditions and active excavations.

6.1.2 Lighting design for these roads was undertaken by DFL-UK as part of the Kent County Council LED Replacement Programme. As a result, DFL have access to all lighting details for the roads adjacent to the Application Site. The lighting design results are summarised in calculation 10506137M-Dartford-Calc-St Clements Way-1-R1, which is included in **Appendix 3**.

6.1.3 Furthermore, mapping of skyward luminance undertaken by the CPRE has been used to inform the assessment of the character of the surrounding area.

## 6.2 Baseline Data

6.2.1 Levels of horizontal and vertical illuminance at the base of the cliff taken from the available lighting calculation for the B255 are shown in **Table 8**:

| Measurement Grid | Illuminance (lux) |
|---|---|
| Average Horizontal | 0.95 |
| Maximum Horizontal | 1.02 |
| Minimum Horizontal | 0.88 |
| Average Vertical | 0.02 |
| Maximum Vertical | 0.07 |
| Minimum Vertical | 0.00 |

Table 8 Modelled Illuminance levels at eastern cliff face

6.2.2 CPRE mapping of the area surrounding the Application Site is shown in **Figure 4**:

Figure 4 CPRE Sky Glow Mapping in the vicinity of the Application Site

6.2.3 Modelled lighting levels indicate that existing lighting at the eastern face of the cliff is below the levels outlined in ILP GN08:2023.

6.2.4 CPRE Sky Glow mapping indicates that the area is highly light polluted, with the Application Site sitting in an area with 16 – 32 NanoWatts / $cm^2$/sr of skyward radiance (sky glow). This is broadly consistent with observations made during the baseline survey of the western cliff face, where significant light pollution was observed.

6.2.5 The relatively low levels of existing lighting in the vicinity of the eastern cliff face are consistent with our expectations for the area as there are limited existing sources of lighting in the vicinity of the western face.

6.2.6 During the baseline survey light sources at the top of the cliff were visible from the western side, indicating that the light levels modelled at the eastern side are accurate as light sources are equally distanced from each side of the cliff.

# 7 Post Occupation Monitoring Levels

## 7.1 Brief

7.1.1 The baseline survey data, combined with lighting calculations prepared for the Proposed Development, can be used to determine likely levels of illuminance at the cliff face for post-installation monitoring.

## 7.2 West

7.2.1 Modelling of the proposed lighting has been undertaken by DFL-UK, which indicates likely levels of horizontal and vertical illuminance at the tunnel entrance with lighting associated with the Proposed Development switched on and switched off.

7.2.2 Visualisations of this modelling are presented in **Figures 5 & 6**:

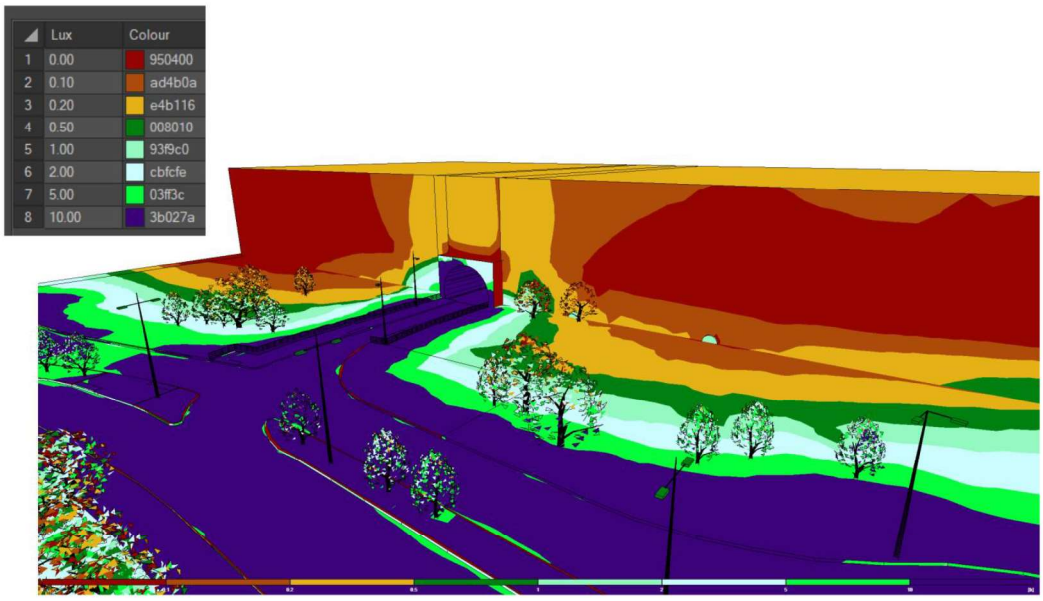



Figure 5 Post occupation lighting levels (Lighting Switched On)

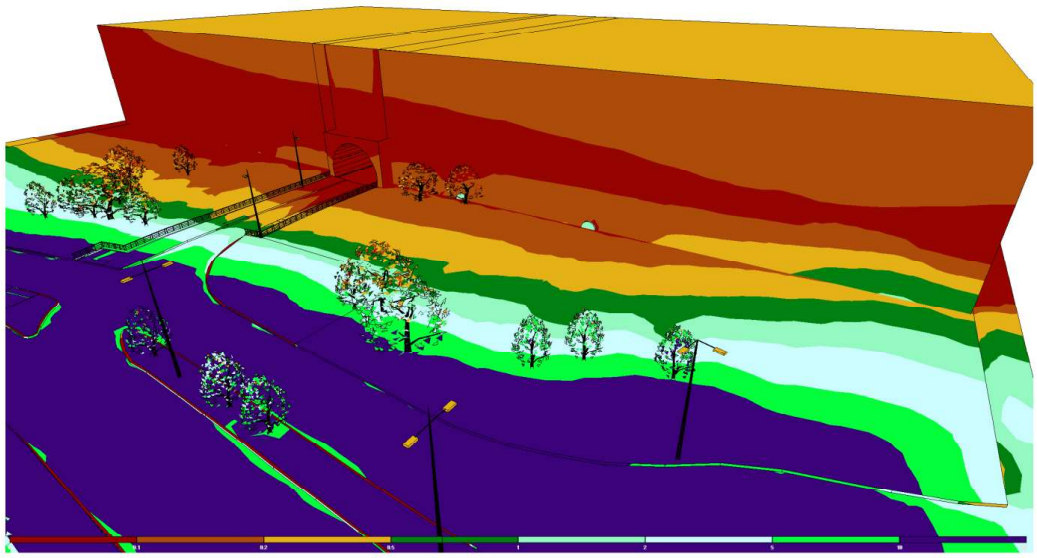


Figure 6 Post occupation lighting levels (Lighting Switched Off)

7.2.3 Modelling indicates that at the western cliff face, lighting levels should be expected to fall below 0.40 lux above the baseline within 10 metres north and south of the tunnel entrance, in accordance with ILP GN08:2023.

7.2.4 Furthermore, modelling indicates that with lighting switched off, lighting levels should be expected to be below 0.10 lux greater than the existing lighting levels on site.

## 7.3 East

7.3.1 Whilst the eastern side of the Proposed Development falls outside of the control of the Fasttrack Bus Network scheme, some assumptions can be made regarding the lighting levels at the eastern cliff face.

7.3.2 As lighting will be implemented in accordance with the adoptable specification; and lighting to the west of the site has also been implemented in accordance with this specification, it can be expected that lighting levels associated with any new development on the eastern side of the tunnel will be broadly consistent with the western face.

7.3.3 As such, lighting levels should be expected to fall below 0.40 lux above the baseline within 10 metres of the tunnel entrance, in accordance with ILP GN08:2023. This level will vary depending upon the mounting arrangements used at the eastern tunnel exit, which fall outside of the control of the Fasttrack Bus Network scheme.

# 8 Conclusions

## 8.1 Brief

8.1.1 This report has been prepared to determine the baseline lighting levels at the western and eastern cliff face of the Fasttrack Bus Network Expansion (Bean Tunnels) scheme.

8.1.2 This report has been informed by light spill modelling of both the existing highways and the Proposed Development. This report has been further informed by a baseline survey of the Application Site.

## 8.2 Baseline Conditions

8.2.1 The Application Site sits in a well illuminated area, adjacent to the Bluewater Shopping Centre to the west. Existing lighting associated with the B255 above the site is visible from the Application Site and leads to visible light pollution within the Application Site boundary.

8.2.2 The Application Site is bounded to the west by an illuminated dual carriageway and is set within a well-lit environment consistent with the conditions for an **E3** Environmental Zone.

8.2.3 Lighting levels were taken within the Application Site, indicating that the cliff face is likely to be illuminated in places above the levels outlined in ILP GN08:2023 where darkness is required upon a feature.

## 8.3 Post Occupation Levels

8.3.1 The report sets out likely lighting levels that will be achieved at the cliff face following the completion and occupation of the Proposed Development and an adjacent scheme that sits outside of the control of the Proposed Development.

8.3.2 At the western face of the cliff, it is unlikely that lighting levels would contribute more than 0.40 lux above the baseline within 10 metres north and south of the tunnel entrance when lighting is switched on. When lighting is switched off, it can be expected that lighting levels will not be 0.10 lux greater than the existing lighting levels on site.

8.3.3 At the eastern face of the cliff, it can be expected (if lighting is installed in a similar manner) that lighting levels will fall below 0.40 lux above the baseline within 10 metres north and south of the tunnel entrance. These levels will be subject to the lighting design of any development to the east of the Application Site, which does not fall within the applicant's control.

8.3.4 As such, it is unlikely that light levels either side of the tunnel entrance will not significantly increase as a result of the Proposed Development. Any increase in light levels will not be above 0.4 Lux of the baseline levels recorded 10 meters from either side of the tunnel entrance.

8.3.5 These levels do not take account of blocking or shading features, such as trees and foliage, which will block some light from reaching the cliff face. The exact effect of these blocking features cannot be determined and as a result they have been left out of any models, presenting the worst-case scenario for possible light spill.

## Appendix 1 – Lighting Designs

See separate files: BRT-TG-XX-ZZ-CA-LI-1301-S3-P04.pdf & BRT-TG-XX-ZZ-CA-LI-1302-S3-P02.pdf

## Appendix 2 – Baseline Survey Methodology

See separate file: 1551-DFL-ELG-XX-SU-EO-13001

## Appendix 3 – B255 Lighting Design Drawings

See separate file: 10506137M-Dartford-Calc-St Clements Way-1-R1

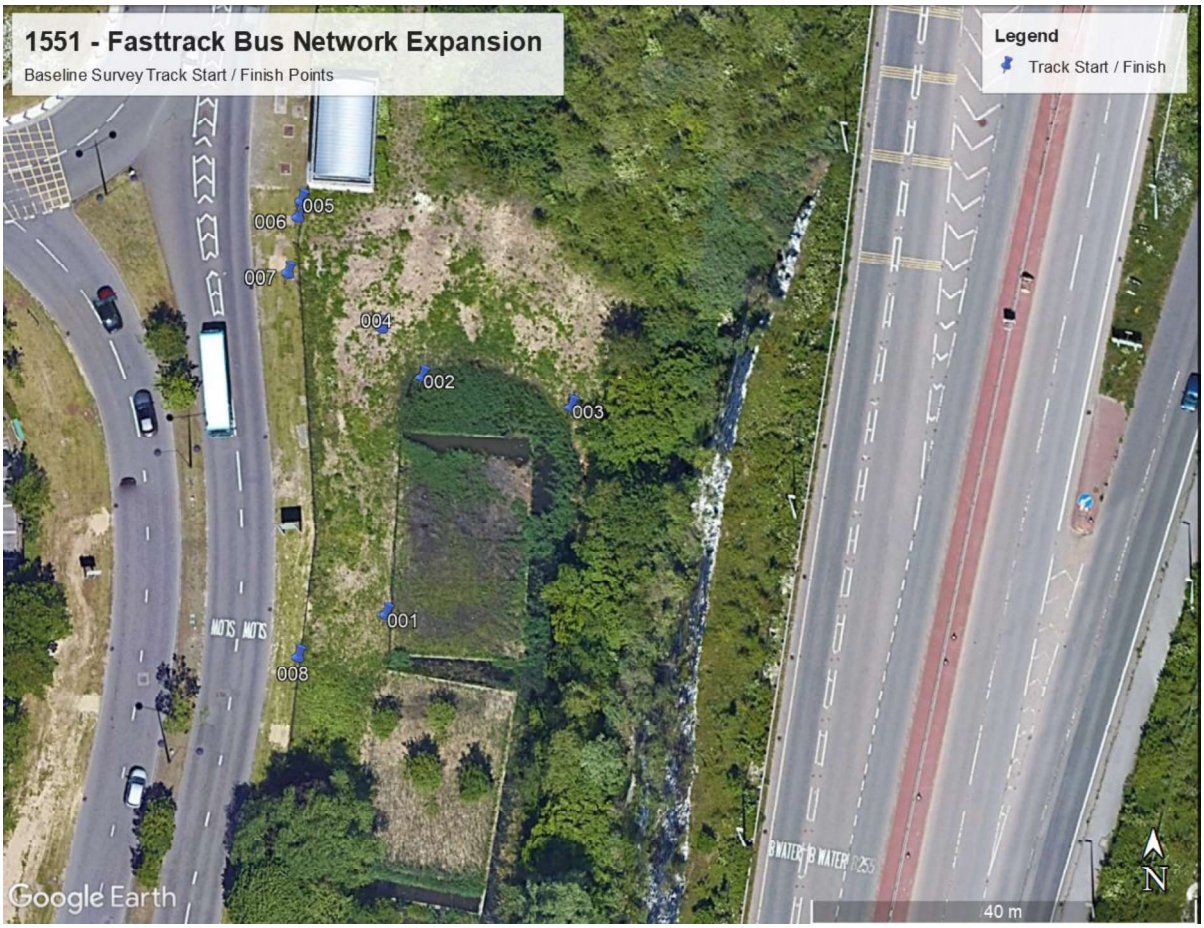
# Appendix 4 – Baseline Survey Results

## Survey Information

| | | | |
|---|---|---|---|
| Project Number: | 1551 Project Name: | Fasttrack Bus Network Expansion (Bean Tunnels) | |
| Site Address: | Bluewater Shopping Centre, Bluewater Parkway, Dartford, DA9 9ST | | |
| Arrival time: | 21:00 | Day time phase start: | N/A |
| Astronomical Twilight: | | Night time phase start: | 22:32 |
| Weather: | Clear | Moon Phase: | New Moon (0% Visible) |

## Illuminance measurement results

| GPS Number | Reading number | Eh | Ev North | Ev East | Ev South | Ev West |
|---|---|---|---|---|---|---|
| 1 | 1 | 0.34 | 1.64 | 0.68 | 1.84 | 4.09 |
| | 2 | 0.42 | 1.95 | 0.72 | 2.13 | 4.42 |
| | 3 | 0.47 | 0.51 | 0.72 | 2.21 | 2.36 |
| | 4 | 0.51 | 1.54 | 0.74 | 2.96 | 4.33 |
| | 5 | 0.49 | 1.35 | 0.64 | 1.86 | 2.71 |
| | 6 | 0.42 | 1.19 | 0.57 | 1.86 | 4.58 |
| | 7 | 1.61 | 1.18 | 0.54 | 2.01 | 4.28 |
| | 8 | 0.25 | 1.09 | 0.5 | 1.33 | 3.59 |
| | 9 | 1.53 | 1.02 | 0.51 | 1.48 | 3.73 |
| | 10 | 1.22 | 0.8 | 0.49 | 1.44 | 3.13 |
| 2 | 11 | 0.71 | 0.9 | 0.5 | 1.57 | 2.45 |
| | 12 | 0.95 | 0.44 | 0.49 | 1.21 | 1.93 |
| | 13 | 0.6 | 0.21 | 0.51 | 0.89 | 1.41 |
| | 14 | 0.35 | 0.23 | 0.48 | 0.66 | 1.07 |
| | 15 | 0.32 | 0.29 | 0.54 | 0.42 | 0.63 |
| | 16 | 0.13 | 0.26 | 0.43 | 0.41 | 0.63 |
| | 17 | 0.1 | 0.06 | 0.02 | 0.45 | 0.62 |
| 3 | 18 | 0.11 | 0.07 | 0.03 | 0.43 | 0.55 |
| 4 | 19 | 1.02 | 0.69 | 0.48 | 1.48 | 2.6 |
| | 20 | 1.04 | 0.18 | 0.45 | 1.51 | 2.08 |
| | 21 | 0.28 | 0.58 | 0.44 | 1.32 | 2.37 |
| | 22 | 0.26 | 0.43 | 0.45 | 1.48 | 2.55 |
| 5 | 23 | 2.35 | 1.38 | 0.47 | 2.19 | 4.21 |
| 6 | 24 | 4.13 | 1.9 | 0.51 | 3.11 | 5.95 |
| | 25 | 5.14 | 2.24 | 0.49 | 4.4 | 6.73 |
| 7 | 26 | 5.28 | 2.47 | 0.49 | 4.95 | 7.47 |
| | 27 | 6.47 | 3.89 | 0.49 | 5.84 | 8.68 |
| | 28 | 7.27 | 3.66 | 0.48 | 7.09 | 9.16 |
| | 29 | 8.35 | 2.94 | 0.5 | 8.2 | 10.52 |
| | 30 | 8.8 | 2.42 | 0.53 | 8.16 | 14.02 |
| | 31 | 10.51 | 1.95 | 0.57 | 6.01 | 15.07 |
| | 32 | 10.13 | 2.46 | 0.6 | 4.27 | 13.87 |
| | 33 | 9.4 | 4.54 | 0.58 | 2.53 | 15.12 |
| | 34 | 10.72 | 7.56 | 0.64 | 1.61 | 15.94 |
| | 35 | 10.88 | 7.02 | 0.74 | 3.44 | 10.02 |
| | 36 | 7.67 | 6.94 | 0.75 | 4.78 | 10.81 |
| | 37 | 9.2 | 7.82 | 0.79 | 6.24 | 10.79 |
| | 38 | 8.03 | 6.45 | 0.77 | 8.53 | 10.87 |
| 8 | 39 | 9.58 | 5.54 | 0.73 | 9.26 | 9.58 |


1551 - Fasttrack Bus Network Expansion
Baseline Survey Track Start / Finish Points
Legend
Track Start / Finish
005
006
007
004
002
003
001
008
Google Earth
40 m
N

## Appendix 5 – Site Photography

SLOW